Ecological Study Of Natural Grassland Community: Nagative And Positive Association Of Plant Species In Taiz, Yemen

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Abstract
The study area was grassland located 5km near Taiz City, Yemen, at a rainy season (June-August 2005). The vegetation community of this area consisted of 72 species representing 27 families: 1- Fabiaceae, 9 species, covering 15%, the most important species, were: *Indigofra spinosa, I. Arabica,* and *Accacia millfera* 2- Poaceae (Graminae) 7 species, covering 16.7%, the most importance species were *Eragrostis papposa, Aristida sp*. 3- Euphorbaceae, 7 species, covering 9.4%, the most important of this family were *Euphobbia inarticulate, E. cactus,* and *Adenium obesum.* 4- Astaraceae, (Compositae), 7 species, covering 9.2%, the most important for this family were: *Flaveria trinerva,* and *Pulicaria jubertii.* 5- Acanthaceae, 6 species, covering 5.7%, the important species was: *Belepharis ciliaria.* In Quantitative charectarestic: the total of vegetation cover for all the species consisted this community was 87.1%. The criteria for each species included: dominance, frequency, abundance and Important value Index (IVI), which used dominance for Association species. The association species indicated that *Cissus rutindofolia* (Vitaceae), was in negative state with *Fagpnia indica,* (Zygophyllaceae), and *Eragrostis papposa* (Poaceae), and in positive state with *Hypostis farskalei* (Acanthaceae). Whereas *Heliotropium aegyptica* (Boraginaceae) was in negative state with *Aerva javanica* (Amaranthaceae) and with *Commicarpus fruticosus* (Nectaginaceae), but this species (*H. aegypticum)* was in positive state with *Belepharis ciliaria* (Acanthaceae). Whereas *B. ciliaria* has a significantly positive relation with *E. papposa* and *Aerva javanica.*

Introduction
The objective of this study was to explore and observe the natural flora of quantitative vegetation in this area. The quantitative study of the vegetation constitutes is the basic principle for successive studies since it offers a details information's study of the area, indicating details to vegetation quantitative characteristics, such as density, vegetation cover, dominance abundance, and important value index (IVI). There were some studies carried out in Yemen such as Al Dubaie, and Al Khulaidi 1990; Al Khulaidi, 1992; Al Gifri and Hussein 1993; Al Khulaidi 1997 concerning about flora in Yemen.

The existing species of Euphorbaceae family, particularly *Euphorbia cactus* and *E. inarticulata* which found in the community under investigation, help and strength the cohesiveness soil, and prevent its erosion and seep-away Al Khulaidi 1992. It was observed that the gathering of firewood or remove plants under any reason lead to disappearance species, because of quick invasion the gap spaces by harmful species (un-grazing plants). Thus the natural environment is replaced by degradable environment (Chesson 2008; Vitoz *et al.* 2011).

The environment degradation which has occurred in the area understudy lead to invade this area by harmful plants, such as *Flaveria trinerva, Forskolea tenacissima* and *Tagetes minuta* which have obstructed the growth of other associating plants by invading the space through the enormous production seeds (Greig-Smith 1989; Grime 2001; Harpole & Suding 2007), or throw the extraction of inhibitor chemical substances, (Saadawi *et al.* 1993; Rice 1984; Kuang and Chesson 2010) such as by Tagets minuta. The importance of negative and positive association will help for grassland management to find out the best growth grassland community (Grime 2001).

Location and Methods
Taiz is located between latitude 13° - 5 & 13° - 68 and longitude 43° - 31 & 44° - 53. The study was carried out by using randomizing quadrates, as described by Greig-Smith 1989; Kershow and looney 1990. Ninety sample quadrates were taken for the sit (area about 2500 m^2). The number of individual plants for each species was counted in each quadrate, as well as the cover percentage.

The observation was carried out at the rainy season between 23^{th} June to 4^{th} August 2005. The quantitative estimation were calculated as in Greig-Smith 1989:

1-Vegetation cover percentage 2- Density, 3- Abundance, 4- Frequency, 5- Dominance which equal the total density plus vegetation cover for each species. 6- Importance Value Index (IVI) equal, total of relative density plus relative frequency plus relative dominance. 7- Association species, was calculated by method of observed and expected number of joint occurrences in the same quadrates of pair of species, (Kershaw and Looney 1990). 8- pH , EC, OM, $CaCO_3$, P^{+++} , and K^{+} in area soil, were analyzed in the Agricultural research lab. Taiz, as in (Allen *et al.* 1974).

Results and Disscusion
The site was alkaline soil as indicated by pH (8) value (Table 1), EC was relatively low value, indicating low salinity in this area, which help plant to growth well (Sheltot, 2004). Organic matter was ranging 1-2% which is expected at the semi-drought area (Shaltout 2004) as in Yemen. The amount of K^{+} and $CaCo_3$ were at moderate level (8 - 8.25%), whereas

phosphorous (P^{3+}) was fairly low (3 – 6) ppm, while K^+ was moderate.

Table 1: Soil characteristics of the area under investigation.

pH	EC	OM %	$CaCO_3$ %	P^{+++} ppm	K^+ ppm
8	.75	1 - 2	8– 8.25	3- 6	220- 280

Seventy two plant species forming the whole vegetation of the area understudy as shown in (Table 2) were identified in 27 families. The majority of those species distribution are in the following families. 1- Fabiaceae, (9 species), (Leguminoseae) (nine species) covering 15%, the important species of this family was *Indigofere spinosa, I. Arabica*. 2- Euphorbaceae (7 species), covering 9.4%, the most important species of this family were *Euphorbia cactus, E. inarticulate*, of quantitative characteristics. 3- Astaraceae (Compositae) family, consist of 7 species, covering 9.2%. The most important species of this family were harmful plant as *Flaveria trinervia.* 4- Poaceae (Graminae), 7 species, covering 16.7%, the most importance species were *Eragrostis papposa, Aristida* 5- Acanthaceae (5 species) covering 5.6%, the important specie were *Belepharis ciliaria* and *Ruellia patula*. 6- Asclepidaceae (4 species), coverage 1%. 7- Amaranthaceae, Aminaceae, Nectaginaceae, and Boraginaceae, which consist three species for each family. 8- Cuparaceae and Solanaceae (2 species for each one). 9- The rest of 14 families, each family represent by one species only.

Table 2: Species and families composition of the area understudy, with vegetation quantitative characteristics, Density (Den. M^{-2}), Vegetation Cover (Cov.%), Dominance (Do %.), Frequency (Freq. %.), Abundance (Abun.), and important value index IVI). Scientific name of species according to Al Khulaidi 1992.

Seq	Scientific name	Family name	Den. m^{-2}	Cov. %	Do.%	Freq. %	Abu.	IVI
1	*Acacia etbaica*	Fabiaceae	0.1	4.0	1.0	2	0.7	1.1
2	*Acacia millifera*	Fabiaceae	0.1	1.1	1.3	5	1.3	2.4
3	*Acalypha fruticosa*	Fabiaceae	0.1	0.1	0.1	1	0.3	0.2
4	*Adenium obesum*	Euphorbaceae	0.1	0.7	0.7	2	0.3	2.3
5	*Aerva javanica*	Amaranthaceae	0.5	2.3	2.7	29	1.7	6.9
6	*Alternathera pungenus*	Amaranthaceae	0.1	0.1	0.1	2	0.3	0.3
7	*Aloe sp.*	Aloeceae	0.1	0.1	0.1	1	1.0	0.9
8	*Anisotes trisulcus*	Acanthaceae	0.1	0.2	0.2	1	0.3	0.7
9	*Aristida sp.*	Poaceae	1.1	3.2	4.0	30	7.8	9.5
10	*Arthraranum prono*	Poaceae	0.3	0.5	0.8	7	3.1	3.3
11	*Becium Sp.*	Aminaceae	0.1	0.2	0.3	4	1.2	0.8
12	*Belepharis ciliaris*	Acanthaceae	3.0	3.4	6.4	30	10.7	15.2
13	*Boerhavia repens*	Nyctaginaceae	0.2	0.6	0.8	10	1.7	2.2
14	*Cadaba farinosa*	Cupressaceae	0.1	0.4	0.4	1	0.3	0.8
15	*Cadia purpurea*	Fabiaceae	0.1	0.3	0.3	1	0.3	0.4
16	*Calotropis procera*	Euphorbaceae	0.2	0.6	0.6	2	9.7	0.7
17	*Caralluma penicilata*	Asclepadiaceae	0.1	0.2	0.2	1	0.3	0.3
18	*Cassia italica*	Fabiaceae	0.3	1.7	2.0	18	1.9	4.9
19	*Cenchrus ciliaris*	Poaceae	0.1	0.1	0.1	1	1.0	0.3
20	*Cissus rutindofolia*	Vitaceae	0.4	3.0	3.4	6	1.0	8.2
21	*Cistanche phelypaea*	Orabanchaceae	0.1	0.1	0.1	1	0.3	0.5
22	*Citrullus colocynthis*	Cucurbitaceae	0.1	0.1	0.1	2	0.7	0.4
23	*Commelina sp.*	Commelinaceae	0.2	0.4	0.5	3	1.8	1.3
24	*Commicarpus helenae*	Nyctaginaceae	0.2	1.1	1.4	16	1.6	3.7
25	*Commicarpus fruticosus*	Nyctaginaceae	0.3	4.7	5.3	14	0.9	13.3
26	*Conyza Sp.*	Aminaceae	0.3	0.5	0.7	8	1.1	1.6
27	*Cynodon dactylon*	Poaceae	1.6	2.4	4.0	18	1.3	9.7
28	*Ecbolium violaceum*	Acanthaceae	0.1	0.2	0.3	2	1.5	0.9
29	*Eragrostis papposa*	Poaceae	8.1	9.3	17.5	65	11.8	39.7
30	*Euphorbia cactus*	Euphorbaceae	o.1	2.6	2.7	8	0.8	4.9
31	*Euphorbia granulata*	Euphorbaceae	1.8	1.7	3.5	28	4.9	11.7
32	*Euphorbia hirta*	Euphorbaceae	0.3	0.3	0.6	3	3.1	1.6
33	*Euphorbia inarticulata*	Euphorbaceae	0.1	3.3	3.4	11	1.2	4.7
34	*Fagonia indica*	Zygophyllaceae	1.0	2.8	3.7	43	2.1	15.0
35	*Flaveria trinervia*	Asteraceae	3.2	3.2	6.4	20	8.7	12.3

36	*Forskalea tenaclssima*	Utricaceae	1.0	1.4	2.4	8	5.4	4.5
37	*Gomphorcarpus fruticosus*	Asclepadiaceae	0.1	0.1	0.1	1	0.1	0.4
38	*Grewia erthraea*	Tiliaceae	0.1	0.3	0.3	2	0.3	0.6
39	*Heliotropium sp.*	Boraginaceae	0.7	1.2	1.9	11	2.3	3.3
40	*Heliotropium aegypticum*	Boraginaceae	1.4	5.8	7.2	41	3.3	15.0
41	*Heliotropium longiflorum*	Boraginaceae	0.1	0.1	0.1	1	0.3	0.3
42	*Hibiscus defersil*	Malvaceae	0.1	0.2	0.3	5	0.7	1.1
43	*Hypoestes forskalei*	Acanthaceae	0.2	0.2	0.8	7	2.1	3.2
44	*Indigofera arabica*	Fabiaceae	2.3	3.3	5.6	49	4.6	15.7
45	*Indigofera spinosa*	Fabiaceae	0.6	4.0	4.5	26	1.4	12.4
46	*Justicia flava*	Fabiacea	0.2	0.2	0.4	11	1.7	2.7
47	*Klenia odora*	Astaraceae	0.2	0.4	0.4	2	0.7	1.9
48	*Lantana salvifolia*	Verenaceae	0.1	0.1	0.1	1	0.3	0.2
49	*Maerua triphylla*	Capporaceae	0.1	0.9	0.9	5	1.1	3.9
50	*Ochradenus baccatus*	Resedaaceae	0.1	0.6	0.6	1	0.3	1.3
51	*Ocimum hadiense*	Aminaceae	2.4	4.6	7.0	47	3.9	14.5
52	*Pavetta longiflora*	Rubiaceae	0.1	0.3	0.3	1	0.3	0.3
53	*Pergularia tomentosa*	Asclepiadaceae	0.1	0.4	0.5	6	0.5	1.2
54	*Pulicaria jaubertii*	Astaraceae	1.5	2.9	4.4	29	4.1	9.7
55	*Pupelia lappaceae*	Ammaranthaceae	0.1	0.1	0.2	2	0.7	1.3
56	*Reichardia sp.*	Astaraceae	0.1	0.4	0.5	7	0.9	1.6
57	*Rhynchosia malacophylla*	Fabiaceae	0.1	0.3	0.9	3	0.7	1.2
58	*Ricinus communis*	Euphorbaceae	0.1	0.2	0.2	1	1.0	0.2
59	*Ruellia patula*	Acanthaceae	0.6	1.6	2.3	13	2.6	5.9
60	*Sansevieria ehrenbergii*	Agavaceae	0.1	0.5	0.6	2	1.2	1.2
61	*Sansevieria quanensis*	Agavaceae	0.1	0.1	0.1	1	0.3	0.2
62	*Sarcostemma viminate*	Asclepadiaceae	0.3	0.3	0.3	2	0.3	0.5
63	*Seddera arabica*	Convolvulacea	0.1	0.1	0.1	1	0.3	0.3
64	*Solanum incanum*	Solanaceae	0.1	1.4	1.5	5	1.2	2.9
65	*Tagetes minuta*	Astaraceae	1.1	1.8	2.9	19	3.2	6.2
66	*Tetrapogon sp.*	Poaceae	0.2	0.5	0.7	6	4.2	2.0
67	*Tragus racemosus*	Poaceae	0.7	0.7	1.4	9	4.9	3.3
68	*Tribulus terrestris*	Zygophyllaceae	1.6	2.4	4.0	30	4.6	7.9
69	*Tridax cumbenus*	Astraceae	0.3	0.4	0.7	3	1.8	0.8
70	*Vernonia sp.*	Astaraceae	0.1	0.1	0.1	1	0.3	0.2
71	*Withania somenifera*	Solanaceae	0.1	0.5	0.6	2	0.3	1.3
72	*Ziziphus spina-christi*	Rhamnaceae	0.1	0.1	0.1	1	0.1	0.2

Eragrostis papposa (poaceae), grazing plant, recorded the highest characteristics of density (8.1), vegetation cover (9.3%), Dominance (17.4), frequency (65%), Abundance (11.8), this mean that this species in very high spatial clumped rhizome, and the (IVI) about 40. Then *Indigofera Arabica* (Fabiacea) and grazing plant, the IVI, 15.7, and the frequency 40%. The highest IVI family was Poaceae, IVI = 67.8, then Fabiaceae, IVI = 40.2, then Astaraceae, IVI = 37.7, then Euphorbaceae, IVI = 26.1, finely Acanthaceae, IVI = 25.9.

Growing few number of trees in this community for Genera *Acacia*. whereas shrubs plants for *Euphorbia* as *E. cactus* , *E. inarticulate, Adenium obesum* and *Ochradenus baccatus.* The rest of the Community were grasses Poaceae (Graminae), consist of 5 species, covering 15.9% the most important were *Eragrostis papposa*, covering 9.3% , *Aristida sp.* and *Cynodon dactylon*, covering 2.4%

Cistanche phelypaea is a parasite on genus *Acacia*. Some species (harmful species) appeared only in rainy season, such *Faveria trinervia*, *Tagetus minuta* and *Forskohlea tenacissima*, which increase substantially at the rainy season (Mahdi and Al Khulaidi 1999; Wilson 2011), which effected the growth and blooming of natural plant species, which its economical species, as grazing plants. The undesirable species invade the area by mass production of seeds, which gradually replaced the available species or more likely by extracted chemical substances inhibited the growth of other species associated (Rice 1984; Saadawi *et al*. 1993; Barot and Gignoux 2004)

Some places in the area understudy represent most degradation, which grew some undesirable or harmful, annual species, which not useful for grazing, those species indicates as degradation area understudy, such as *Forskahlea tenacissima, Tagets minuta, Euphorbia hirta* and *Flaveria trinervia* those species linked with ecological degradable condition (Mahdi and Al Khulaidi 1999).

Some species were observed living in spatial clumped, as noted in Table 2, which represented by abundance such *Eragrostis papposa* 11.8, *Aristida sp*, 7.8, Tragus racemosus 4.9 (Poaceae). *Belepharis ciliaria* 10.7 (Acanthaceae), *Calotropis procera*,(9.7) (Euphorbaceae), those species are perennial, which clumped by rhizomes. Whereas species *Flaveria trinervia* 8.7 (Asteraceae) is annual plant, this clumps caused by mass seeds production not by rhizomes. The spatial clumped due by rhizomes linked them together offered a powerful competition (Orney 1994; Wijesingh and Hutchings, 1997).

Noticed that more common species in the area understudy was *Eragrosted papposa*, this plant is perennial, had rhizome, which invaded space available semi-poorly soil (Yadzis 1986). This species is grazing plant and the height of this species was about 5cm, which suffering of overgrazing, particularly by goats.

Some species had high value of frequency, such *Aristida sp.*, *Faongonia indica*, *Justcia flava*, *Cynodon dactylon* and *Indigofra Arabica.* Those species grow well under shadow of jungle trees. Whereas at the where degradation places was obviously, the undesirable species were relatively at large quantities, *Euphorbia granulate*, *Belpharis ciliaria*, *Aerva javanica*, *Pulicaria jubertii*, *Forskahlea tenacissima*, *Flaveria trinerva*, *Ruellia patella*, and *Tribulus terrestris.*

Table 2, and Fig.1 shows that species in positive relationship (aggregation) was between *Heliotropium aegypticum* and *Aerva favanica.* The relationship between *Fagonia indica*, *Cissus rotindifolia* and *Hypostes forskalei* was positive as well. Whereas negative relationship (Segregation) was observed between *Eragrostis papposa* and *Cissus rotundifolia.* It was noticed that *Eragrostis papposa* decreased at shadow position, the negative relationship between *Heliotropium aegypticum* and *Commicarpus plumbagineus* might be because of exudates inhibition substance by *Aerva javanica* and *H. aegypticum*, effected the growth of some particular association species (Al Khulaidi 1992; Al Khulaidi 1997; Yang *et al*. 2010). This relationship positive and negative between species summarized as follows:

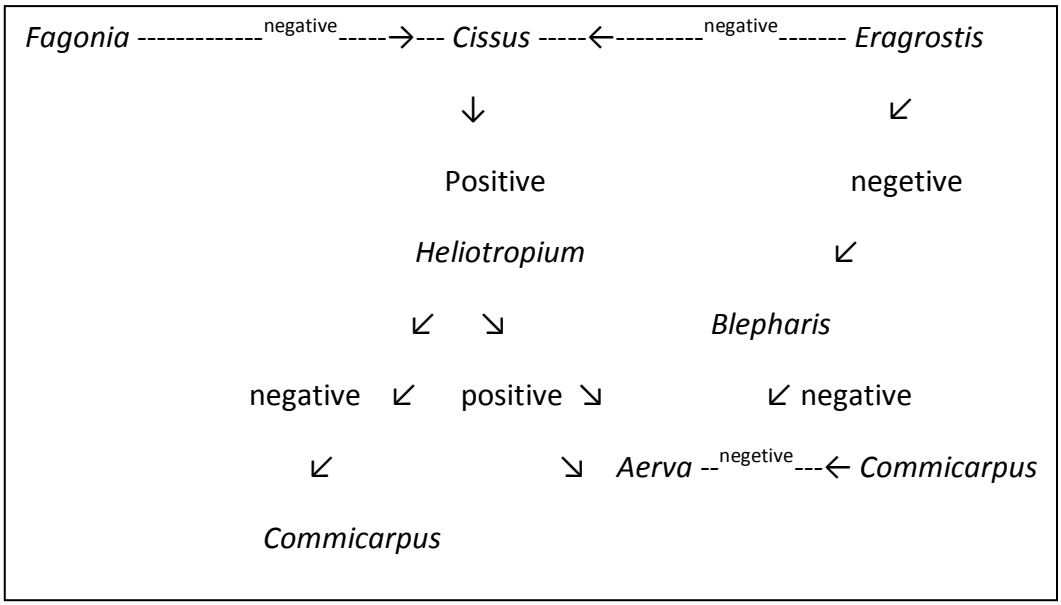

Figure 1: Diagram of negative and positive association between some dominant species under investigation.

This phenomenon required more study to know the plant community relationship, positive and negative, particularly by sort of manner named nearest neighbor.

Biological diversity: measurement of richness species diversity in 2500 m^2 as follows: $d = s/\sqrt{n}$ (Whittaker 1972). s = Summation of absolute amount of all species (IVI)= 307.1. n = total number of species = 72. Therefore the diversity (d) = 4.11 which regard as moderate value at arid regions (Shaltout 2004).

Table 3: Observed and expected number of joint occurrences of pairs of species.

Heliotro.	20	*Eragrostis*								
Aegyticum.	16.4	*papposa*								
Indigofe.	17	11	*Heliotropium*							
spinosa	13.5	8.7	*aegypticum*							
Fagonia	18	12	6	*Indigofra*						
Indica	14.8	10.1	8.4	spinosa						
Commicarpus	8	1	1	3	*Fagonia*					
fruticosus	6.5	4.2*	3.4	4.1	indica					
Aristida	8	6	6	8	2	*Commicarpus*				
Sp.	9.2	6.6	5.3	6.4	2.4	*fruticosa*				
Cissus	4	6	3	1	0	1	*Aristida*			
Rotundifol.	7.4**	4.9	3.9	4.3*	1.9	3.0	sp.			
Hypoestes	8	6	5	2	2	0	8	*Cissus*		
Forskalei	8.5	5.6	4.5	5.4*	2.3	3.4	2.5***	*routundifolia*		
Ocimum	8	6	6	6	1	4	2	1	*Hypostes*	
Hidiense	6.9	4.7	3.7	4.4	1.8	2.8	2.0	1.1	forskalei	
Cynodon	5	3	4	1	0	3	1	3	1	*Ocimum*
dactylon	3.7	2.4	2.0	2.4	0.9	1.5	1.1	1.3	1.0	*hadiense*
Blepharis	14	12	8	9	1	3	3	5	3	3 *Cynodon*
Ciliaria	9.7*	9.6**	5.3	6.1	2.4	3.8	2.8	3.2	2.6	1.4 *dactylon*
Aerva	9	7	4	8	0	5	1	3	2	2 7 *Blepharis*
Javanica	10.0	6.8**	5.3	6.4	2.6**	4.1	3.0	3.8	2.8	1.5 3.8 *ciliaria*

* represent p≥0.05, ** represent p≥0.01 and *** represent p≥0,001.

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دراسة بيئية لمجتمع مرعى طبيعي: ألترافق السلبي والايجابي للنباتات في منطقة تعز، اليمن

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الملخص

ألمنطقة تحت الدراسة هي مرعى يقع على بعد 5 كلم عن مدينة تعز–اليمن. تمت ألدراسة في فصل ألأمطار (حزيران–آب 2005). ألمجتمع النباتي لهذه ألمنطقة يتكون من 72 نوع نباتي، تمثل 27 عائلة: 1– ألعائلة ألبقولية Fabiacea (Leguminosea) لها تسعة أنواع تغطي 15%، أهمها هي: *Indigofra spinosa*، *I. arabica* و *Accacia millifera*. 2– ألعائلة ألنجيلية Poaceae (Graminae) تغطي 16.7%، أهم أنواعها هي: *Eragrostis papposa* و *Aristida sp*. 3– عائلة أم الحليب Euphorbaceae تتكون من 7 أنواع تغطي 9.4%، أهمها هي *Euphorbia inarticulate* و *E. cactus* 4– ألعائلة النجمية أو ألمركبة Astaraceae (Compositae) ولها 7 أنواع تغطي 9.2%، أهم أنواعها هي: *Flaveria trinerva* و *Pulicaria jaubertii* 5– ألعائلة ألأكانثية Acanthaceae لها 6 أنواع تغطي 5.7%، ألنوع ألمهم فيها هو *Blepharis ciliaria*. من ألصفات ألكمية لهذا ألمجتمع ألنباتي، أن مجموع ألغطاء ألخضري لجميع الأنواع ألمكونة للمجتمع يبلغ 87.1%. لقد تم حساب الصفات الكمية لكل نوع نباتي في هذا المجتمع والذي يتضمن الكثافة، التغطية،السيادة، ألتردد، ألغزارة، ثم دليل الأهمية. وقد استخدمت السيادة لتحديد الترافق بين الأنواع. إن هذا الترافق بين الأنواع أوضح إن ألنوع *Cissus rutindofolia* (Vitaceae) كان في حالة ترافق سلبي مع *Fagonia indica* (Zygophyllaceae)، وأيضا مع *Eragrostis papposa* (Poaceae)، وفي حالة ترافق ايجابي مع *Hypostes farskalei* (Acanthaceae). بينما ألنوع *Heliotropium aegyptica* (Boraginaceae) بعلاقة سلبية مع *Aerva javanica* (Amaranthaceae) وأيضاً مع ألنوع *Commicarpus fruticosus* (Nectaginaceae)، ولكن له علاقة إيجابية مع ألنوع *Blepharis ciliaria* (Acanthaceae)، والأخير له علاقة إحصائية مهمة سلبية مع *E. papposa* و *A. javanica*